EFFECTS OF THREE MALATHION TREATMENTS ON FECUNDITY, LONGEVITY AND WEIGHT OF THE HOUSE FLY, *MUSCA DOMESTICA* L.

by

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INTRODUCTION

Limited studies have shown that an alteration in the biology of insects may occur when insecticide resistance develops. Most of the recent studies have been made after use of the chlorinated insecticides.

Recent observations include that of the Public Health Service (Anon, 1955) which reported that privies which were a poor source of house flies before residual treatment became an increasingly important source following treatment. Hueck, et al. (1952) reported that the European red mite (Metatetranchus ulmi Koch) reproduced at a higher rate as a result of DDT treatment. Knutson (1955) reported that fruit flies (Drosophila melanogaster Meigen) surviving dieldrin treatment produced 5.8 per cent more adults than controls. Afifi and Knutson (1956) reported that house flies surviving one treatment of dieldrin produced 16.7 per cent more adult progeny, their untreated F_1 produced 69.2 per cent more adult progeny and their untreated F_2 produced 9.3 per cent more adult progeny.

No work is known to have been reported on this subject using the organic phosphorus insecticides. This investigation was concerned with the effects of three treatments of malathion on certain aspects of the biology of the house fly.

MATERIALS AND METHODS

A laboratory strain of house fly (designated KUN) having no history of insecticide exposure, was used in this investigation. The investigation was conducted in an insecticide-free room with a constant temperature of 80°F. ± 2°.

After mass rearing to obtain large numbers of flies, one segment of the

population was randomly selected as a control, designated "UT" (untreated). The other segment of the population, "T" (treated), was treated with malathion in the larval stage for three consecutive generations at a dosage which killed 40 to 60 per cent of the larvae. To determine this dosage, various concentrations ranging from 0.5 to 5 p.p.m. of 95 per cent malathion in CSMA standard fly larval media were prepared as described below. Each concentration of malathion was diluted with acetone to 100 ml. and mixed with 1600 ml. dry CSMA fly larva media in 10 pound waxed paper cheese tubs. These tubs were covered with cheese cloth and placed before a fan for 24 hours to allow the acetone to evaporate. Media containing 100 ml. of acetone without malathion were used as a control. After 24 hours, water, yeast and dimalt were added to both the control and treated tubs. Three-tenths of a ml. of eggs (approximately 2,000 eggs) from the fifth egg laying day of the parents was then planted in each tub. After eight days, the pupae were separated and counted. The LD_{50} (2 p.p.m.) changed very little if any after the first of the three consecutive treatments given; consequently, this became the "treated" group.

The resulting pupae were placed in cages 10" x 10" x 10". The cages were made with screened tops and sides, a sliding glass panel for a front and rubber back with a hole through which the arm could be thrust, to facilitate feed changing, removing eggs, and other manipulations. A jar lid three inches in diameter was used to close this hole between manipulations.

Twenty-four hours after the flies emerged, they were transferred by a moving air stream into one quart cylindrical cardboard cartons with screened ends in preparation for sexing. Carbon dioxide anaesthesia was used to facilitate handling and sexing. The use of CO_2 anaesthesia was kept at a minimum and well within the limits indicated by Williams (1946).

Five hundred males and 500 females were transferred into each cage. A total of 17 cages were used for the treated flies and the same number for the untreated flies.

Food and water were changed daily. The food consisted of a mixture of one volume granulated sugar to two volumes of powdered milk. Oviposition site and water source consisted of crystallization dishes, 70 mm. in diameter by 50 mm. high, in which cork covered with muslin six inches by six inches was floated in water.

Longevity was determined by making a daily record of the number of dead parent male and female flies. They were dragged out of the cages with a looped wire as the front glass panel was raised high enough to permit entry of the wire.

To record egg production in each cage, the eggs which had been oviposited on muslin were washed off with a steady stream of water from a polyethylene wash bottle into a 25 ml. beaker. The eggs were concentrated by withdrawing the excess water with a pipette. The eggs were then transferred to a 15 ml. graduated centrifuge tube and measured volumetrically. The volume of eggs was converted to number of eggs since each 0.3 ml. equals 2,000 eggs $\pm$ 180.

After egg counts from each cage were recorded each day, the eggs from all 17 replicates were thoroughly mixed. To determine hatchability, moistened filter paper was fitted into each of three inverted petri dishes. Two hundred eggs from the combined collection were placed in each dish in groups of ten eggs to facilitate counting. The filter papers were then kept saturated by adding water at intervals. Records of hatched and unhatched eggs were made at 24 and 48 hours.

To determine pupation and emergence approximately 2,000 eggs, from the

same batch of mixed eggs of the 17 replicates, were planted daily in standard CSMA fly larva media in ten pound cheese tubs. Eight days following planting of each daily batch of eggs, the pupae were separated and counted. The resulting pupae from each daily batch of mixed eggs were then placed in cages without food and water. After all flies had emerged and died, the number of emerged flies were sexed and recorded. In a few cases some of the larvae had not pupated at the end of eight days; in these cases the larvae were held until all pupation had occurred.

Data were based on 21 days following initial oviposition because egg production was almost negligible thereafter.

For weight studies, the resulting adult progeny were grouped into consecutive two day periods. From both the treated and untreated group, 100 flies replicated eight times for both sexes, were placed in petri dishes. These were placed in a hot air oven and desiccated at 115°F. for 72 hours. They were then placed in calcium chloride desiccating containers made of one pound coffee cans, and sealed with masking tape until cooled. Subsequently, the flies and dishes were weighed with a Christian Becker chainomatic balance. The dishes with flies were then replaced in the hot air oven and the process repeated, this time for 12 hours, to derive a constant weight. The weight of 100 flies was derived by subtracting the dish weight from the dish-fly weight.

For statistical analysis of egg production, the number of eggs from each replicate was cumulated each successive day. Eggs from the treated and untreated were then analyzed for significance by the Wilcoxon (1945) and Mann and Whitney (1947) ranking test. A similar analysis was made for female fly days (the cumulative number of females remaining alive each day) and for average number of eggs per female fly day; this figure on any given day was

derived by dividing the cumulated egg total by the respective female fly day.

Hatchability, pupation and emergence were analyzed for significance by chi-squaring the weekly totals and the three week summary. A similar procedure was followed for analyzing "calculated adult progeny".

In the weight studies, the eight replicates of the treated and untreated flies were analyzed for significance by "Student's t-test".

RESULTS AND DISCUSSION

Tables 1, 2, 3 and 4 present the daily "actual" cumulative egg production of the treated and untreated parents, along with resulting hatchability, pupal attainment and calculated cumulative adult emergence, without taking into consideration the relative daily survival of treated and untreated parent females available to produce eggs. Table 5, on the other hand, takes into consideration the daily number of living treated and untreated parent females available to produce eggs each day ("female fly day", or longevity). Table 6 presents the calculated resulting cumulative average number of eggs per female fly day.

Actual Egg Production

Table 1 shows that the cumulative egg production during the first 14 days was greater in the treated than in the untreated group. From the fifteenth through nineteenth days it was equal, while on the twentieth and twenty-first days egg production was less in the treated group.

The net result was that, although the treated flies produced more eggs in the early part of their productive life, by 21 days the untreated had produced more eggs. By 21 days the treated group had produced 2,760,592 eggs

Table 1. Cumulative total egg production of 17 replicates of malathion treated (T) and untreated (UT) flies on successive days following initial oviposition using Wilcoxon, Mann, Whitney ranking test.

Successive days	Cumulative total eggs T	Cumulative total eggs UT	Yo	P(Y>Yo)	Conclusion
1	363,500	98,334	3.38	0*	T > UT
2	699,164	427,945	4.98	0*	"
3	894,083	555,176	4.46	0*	"
4	1,229,081	698,399	4.91	0*	"
5	1,394,667	927,926	4.77	0*	"
6	1,631,040	1,163,754	4.67	0*	"
7	1,858,517	1,388,171	4.60	0*	"
8	1,982,049	1,568,698	4.25	0*	"
9	2,200,164	1,756,154	4.36	0*	"
10	2,326,371	1,878,024	4.50	0*	"
11	2,459,904	2,045,140	4.25	0*	"
12	2,550,317	2,195,881	3.63	0*	"
13	2,610,114	2,343,858	2.91	.002	"
14	2,665,809	2,480,140	2.22	.013	"
15	2,703,904	2,598,435	1.02	.154	T=UT
16	2,727,731	2,694,373	.43	.334	"
17	2,734,223	2,765,968	-0.47	.681	"
18	2,742,201	2,820,571	-0.95	.829	"
19	2,746,399	2,874,992	-1.33	.908	"
20	2,755,387	2,917,096	-1.64	.950	T < UT
21	2,760,592	2,957,722	-1.81	.965	"

Table 2. Weekly totals and three week total of hatchability, pupation and emergence of treated (T) and untreated (UT) flies by chi-squaring.

Hatchability[1]

Week		Hatched	Unhatched	Chi-square	Conclusion (with one degree of freedom)
1	UT	3264	936	38.562	T > UT
	T	3490[2]	710		
2	UT	3391	809	59.141	T < UT
	T	3095	1105		
3	UT	2693	1507	38.920	T < UT
	T	2414	1786		
Total	UT	9348	3252	24.360	T < UT
	T	8999	3601		

Pupation[3]

Week		Pupated	Failed to pupate	Chi-square	Conclusion (with one degree of freedom)
1	UT	9876[4]	4124	868.250	T > UT
	T	11934	2066		
2	UT	9039	4961	5.078	T > UT
	T	9220	4780		
3	UT	6950	7050	279.349	T < UT
	T	5562	8438		
Total	UT	25865	16135	9.0575	T > UT
	T	26716	15284		

Table 2 (concl.)

Week		Adults	No Adults	Emergence 5/ Chi-square	Conclusion (with one degree of freedom)
1	UT	8677	3323	131.061	T>UT
	T	10978	3022		
2	UT	8486	5514	6.805	T<UT (slightly)
	T	8273	5727		
3	UT	6309	7691	324.576	T<UT
	T	4838	9162		
Total	UT	23472	16528	14.7425	T<UT
	T	24089	17911		

1/ Based upon 4200 eggs per week.
2/ Actual figure slightly higher because of laboratory accident but not sufficient to influence conclusion.
3/ Based upon 14000 eggs per week.
4/ Actual figure slightly higher because of laboratory accident but not sufficient to influence conclusion.
5/ Based upon 14000, except UT of first week.

Table 3. Mortality among life history stages, during first three weeks, malathion treated (T) and untreated (UT).

	Egg to larva	Larva to pupa	Pupa to adult	Egg to adult
UT	25.8	13.4	2.9	42.1
T	28.6	7.8	6.2	42.6
% difference (T vs. UT)	-2.8	+5.6	-3.3	-0.5

Table 4. Calculated weekly totals and three week total of the number of adult progeny based on actual number of eggs produced per day and corresponding daily emergence rate. Malathion – treated (T) and untreated (UT) – by chi-squaring.

Week		Adults	Not adults	Total eggs	Chi-square	Conclusion (with one degree of freedom)
1	UT	906,372	338,675	1,244,948	16.500	T > UT
	T	1,470,185	388,332	1,858,517		
2	UT	660,168	431,801	1,091,969	15,480	T < UT (slightly)
	T	490,341	316,951	807,292		
3	UT	231,294	246,288	477,582	Extremely large	T < UT
	T	31,519	63,264	94,783		
Total	UT	1,797,735	1,016,764	2,814,499	Extremely large	T > UT
	T	1,992,045	768,547	2,760,592		

and the untreated group 2,957,722 eggs.

Longevity (Female Fly Days)

These data were obtained by cumulating the totals of parent females remaining alive each day (Table 5). Although the female fly days of the treated and untreated groups were about equal the first day, in subsequent days through the eighth day the treated group exceeded the untreated. From the ninth through the eleventh days, the treated were about equal to the untreated. From the thirteenth through the sixteenth days the trend of the first eight days had reversed so that the female fly days of the treated group totaled less than the untreated. From the seventeenth through the twenty-first days this trend became much more pronounced.

Average Number of Eggs per Female Fly Day

To obtain these data, the cumulated daily egg totals in Table 1 were divided by the corresponding parent female fly days (Table 6). These data indicate that the treated group produced a greater number of eggs per female fly day during the entire three weeks.

Correlation of Data on Actual Cumulative Egg Production, Female Fly Days and Cumulative Average Number of Eggs per Female Fly Day

Table 1 shows that actual egg production in the treated group was significantly less than in the untreated group at the end of three weeks, while Table 6 shows the treated group to have greatly excelled the untreated in eggs per female fly day. An explanation lies in Table 5, which shows that, although the treated group excelled the untreated in female fly days during the first eight days, the cumulative totals resulted in a gradual reversal

Table 5. Cumulative female fly days of 17 replicates of malathion treated (T) and untreated (UT) flies on successive days following initial oviposition using Wilcoxon, Mann, Whitney ranking test.

Successive days	Cumulative female fly days		Yo	P(Y > observed Yo)	Conclusion
	T	UT			
1	7,864	7,707	1.09	.14	$T \cong UT$
2	15,642	15,224	1.67	.05	$T > UT$
3	23,325	22,603	1.74	.04	"
4	30,852	29,854	1.77	.04	"
5	38,285	36,971	1.95	.03	"
6	45,523	43,946	2.05	.02	"
7	52,466	50,782	1.95	.03	"
8	59,030	57,441	1.60	.05*	"
9	65,049	63,915	.84	.20	$T \cong UT$
10	70,436	70,153	− .16	.56	$T \simeq UT$
11	75,247	76,125	− .78	.78	"
12	79,506	81,907	−1.53	.94	$T \leq UT$
13	83,222	87,421	−2.02	.98	$T < UT$
14	86,385	92,629	−2.67	.99*	"
15	89,016	97,498	−3.15	"	"
16	91,197	102,031	−3.53	"	"
17	93,012	106,189	−3.94	.999	$T \ll UT$
18	94,481	109,899	−4.22	"	"
19	95,654	113,199	−4.36	"	"
20	96,477	116,108	−4.56	"	"
21	97,099	118,682	−4.60	"	"

Table 6. Cumulative average number of eggs per fly by days of 17 replicates of malathion treated (T) and untreated (UT) flies on successive days following initial oviposition, using Wilcoxon, Mann, Whitney ranking test.

Successive days	Average number of eggs per fly		Yo	P(Y > observed Yo)	Conclusion
	T	UT			
1	46.2	12.8	4.66	0+	T>>UT
2	44.7	28.1	4.98	"	"
3	38.3	24.6	4.43	"	"
4	39.4	23.4	4.91	"	"
5	36.4	25.1	4.39	"	"
6	35.8	26.5	4.53	"	"
7	35.4	27.3	4.50	"	"
8	33.6	27.3	4.19	"	"
9	33.8	27.5	4.50	"	"
10	33.0	26.8	4.56	"	"
11	32.7	26.9	4.50	"	"
12	32.1	26.8	4.43	"	"
13	31.4	26.8	4.05	"	"
14	30.9	26.8	3.88	"	"
15	30.4	26.7	3.63	"	"
16	29.9	26.4	3.57	"	"
17	29.4	26.0	3.43	"	"
18	29.0	25.7	3.46	"	"
19	28.7	25.4	3.50	"	"
20	28.6	25.1	3.53	"	"
21	28.4	24.9	3.53	"	"

of this trend from the ninth day, with an eventual highly significant reversal, so that the female fly days in the treated group eventually was very significantly less than the untreated. This indicates that the eventual outcome of actual egg production at the end of 21 days (Table 1), wherein the treated group produced less than the untreated, was the result of a large reduction in numbers of treated parent females available to lay eggs during the third week of life.

Hatchability, Pupation and Emergence

These data presented in Table 2 were based on the actual number of eggs hatched from an aliquot of 600 eggs per day, and the number of pupations and adult emergences from an aliquot of 2,000 eggs per day.

In all three instances, i.e., hatchability, pupation and emergence, the treated group underwent a greater survival rate than the untreated during the first week.

During the second week, hatchability in the treated group was less than in the untreated. The number of pupae in the treated group was, however, still greater than in the untreated. In the adults, the treated group was, as in the case of hatchability, less than the untreated but not highly so.

During the third week, the treated group underwent a lower survival rate than the untreated in all three instances; this was a complete reversal from the first week.

Summarizing for the entire three weeks, hatchability of the treated group was less than in the untreated. Pupae from the treated group totaled more than in the untreated. Adult emergence from the treated group was less than in the untreated group.

Table 3 presents certain data in Table 2 in terms of per cent mortality

making it more readily apparent to what extent these differences occurred. The treated group underwent a greater mortality in the egg stage (2.8 per cent) and in between the pupal and adult stages (3.3 per cent) but a lesser mortality between the larval and pupal stage (5.6 per cent). A comparison of the overall difference in survival from egg to adult shows that the treated underwent a significantly greater mortality (0.5 per cent) than the untreated, indicating that the losses suffered by the treated group between egg and larva and between pupa and adult exceeded the gain between larva and pupa.

Calculated Total Adult Progeny

While the data in Tables 2 and 3 were based upon results of a standard number of eggs, (viz., 600 eggs in hatchability tests and 2,000 eggs in pupation and emergence tests), Table 4 not only takes these data into consideration but also gives the calculated number of adult progeny to have been expected from the actual eggs produced (Table 1).

During the first week, the treated group was greater than the untreated. During the second and third weeks this trend was reversed. However, the total at the end of three weeks resulted in the treated group producing a calculated greater number of progeny than the untreated, because egg production, which was much greater in the treated group during the first week (Table 1) was also the period when hatchability, pupation and emergence (Table 2) were greater in the treated group. This offset the reversals during the less-productive second and third weeks.

Weights

Table 7 shows that the weights of the male and female adult progeny of

Table 7. Weight (in mg.) of adult male and female progeny replicated 8 times. Malathion treated (T) and untreated (UT) using "Student's t-test".

Successive days (combined in 2's)	Mean weight per 100 T	Mean weight per 100 UT	t	Degrees of freedom	Conclusion
		Females			
1 and 2	304.5	328.3	11.33	14	UT > T
3 and 4	308.5	326.2	9.22	12	"
5 and 6	306.9	329.1	6.61	14	"
7 and 8	300.1	321.8	10.64	"	"
9 and 10	321.6	309.0	4.86	"	T > UT
11 and 12	347.9	324.9	15.44	"	"
13 and 14	349.0	322.4	2.62	"	"
Mean for 14 days	316.2	323.0	2.13	108	UT > T
		Males			
1 and 2	261.8	282.4	7.23	14	UT > T
3 and 4	266.2	288.4	13.37	12	"
5 and 6	267.5	286.0	9.84	14	"
7 and 8	259.6	283.4	9.56	"	"
9 and 10	280.5	269.9	4.57	"	T > UT
11 and 12	289.0	281.2	4.94	"	"
13 and 14	300.2	282.3	11.40	"	"
Mean for 14 days	275.0	281.7	3.03	108	UT > T

the treated parents were less than the untreated during the first eight days, but from the ninth through fourteenth days the trend reversed. At the end of fourteen days, the mean weight of the treated group (275,0 mg. per 100 flies for males, 316.2 mg. for females) in both sexes was less than the untreated group (281.7 mg. and 323.0 mg. per 100 flies, respectively).

While adult progeny of eggs produced during the first week of the parents' life was lighter than that produced from eggs during the second week of the parents' life, at the same time viability in the various life history stages (Table 2) was greatest during the first week. The adult progeny increased in weight as the viability decreased.

CONCLUSIONS AND SUMMARY

Laboratory studies of certain aspects of the biology of the house fly, Musca domestica L., were conducted to determine the effects of three successive treatments with malathion. This treatment consisted of the introduction of malathion into the larval media at a dosage of two p.p.m. on a wet weight basis, which resulted in a mortality of 40 to 60 per cent.

After treatments, the adults were sexed and placed into 17 cages, 500 males and 500 females per cage. Untreated flies were replicated in a like manner.

Daily records were maintained of eggs produced, number of parent females surviving, and number of eggs hatched, resulting pupation, and resulting emergence. All data were statistically analyzed for significance.

On a cumulative total basis the treated flies produced more eggs than the untreated during the first 14 days. Production was about equal through the nineteenth day, and less (2,760,592) than the untreated (2,957,722) by the twenty-first day.

There were more female fly days in the treated group from the second to the eighth day, and less from the thirteenth through twenty-first day, at which time the treated totaled 97,099 and the untreated 118,682 female fly days.

The cumulative average number of eggs per female fly day in the treated group was greater throughout each of the 21 days, averaging 28.4 for the treated group and 24.9 for the untreated group.

The fact that at the end of three weeks cumulative egg production of the treated was less than the untreated while the treated exceeded the untreated in eggs per female fly day is explained by the fact that the female fly days, although greater in the treated than in the untreated during the first eight days, actually underwent a highly significant reversal thereafter. This means that the eventual outcome of egg production was the result of a large reduction in numbers of treated flies available to lay eggs during this period.

The treated flies produced eggs with a greater percentage of hatchability, resulting pupation and resulting emergence during the first week. However, there was a reversal sometime during the second and third weeks. The total for 21 egg laying days resulted in the treated undergoing a greater mortality in the egg (2.8 per cent), between the pupal and adult stage (3.3 per cent) but a lesser mortality between the larval and pupal stage (5.6 per cent). The overall difference, i.e., between egg and adult, however, resulted in the treated suffering greater mortality than the untreated (0.5 per cent) indicating that the losses suffered between egg and larva, and between pupa and adult exceeded the gain between larva and pupa.

The potential adult progeny to have been expected from actual number of eggs produced was also calculated. During the first week, the treated was

greater than the untreated. During the second and third weeks this trend was reversed. However, the total at the end of three weeks resulted in the treated group producing a calculated greater number of progeny than the untreated because the period of maximum egg production occurred during the first week which coincided with the period of greatest hatchability, pupation and emergence.

Weights were based upon constant dry weight of eight replicates of 100 each of adult progeny, resulting from eggs produced during the first 14 days of egg laying by the parents. Weights of the treated flies of both sexes were less than the untreated during the first eight days, but from the ninth through fourteenth days the trend reversed. Taking the entire 14 days as a whole, the treated group (275.0 mg. and 316.2 mg. for males and females respectively) were lighter in weight than the untreated group (281.7 mg. and 323.0 mg. respectively).

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Limited studies and observations have shown that insecticidal treatments sometimes influence reproduction. Most of the recent studies have been made after use of the chlorinated insecticides. No work is known to have been reported on this subject with the organic phosphorus insecticides. This investigation was concerned with the effects of three treatments of malathion on certain aspects of the biology of the house fly.

This treatment consisted of the introduction of malathion into the larval media at a dosage of two p.p.m. on a wet weight basis, which resulted in a mortality of 40 to 60 per cent.

After treatments, the adults were anaesthesized with carbon dioxide, sexed, and placed into 17 cages, 500 males and 500 females per cage. Untreated flies were replicated in a like manner.

Food and water were changed daily. The food consisted of a mixture of one volume granulated sugar to two volumes of powdered milk. Oviposition site and water source consisted of crystallization dishes, 70 mm. in diameter by 50 mm. high, in which cork covered with muslin six inches by six inches was floated in water.

Longevity was determined by making a daily record of the number of dead females and converting this to female fly days (cumulative number of females alive per day).

To record egg production in each cage, the eggs which had been oviposited on muslin were concentrated and measured in a 15 ml. graduated centrifuge tube. The volume of eggs was converted to number of eggs since each 0.3 ml. equals 2,000 eggs $\pm$ 180.

The eggs from all 17 replicates were thoroughly mixed after egg count from each was recorded each day. To determine hatchability, moistened filter paper was fitted in each of three inverted petri dishes. Two hundred

eggs from the combined collection were placed in each dish in groups of ten eggs to facilitate counting. The filter papers were kept saturated and records of hatched and unhatched eggs were made at 24 and 48 hours.

To determine pupation and emergence, approximately 2,000 eggs from mixed eggs of the 17 replicates were transferred daily into standard CSMA fly larva media. The resulting pupae and emerging adults were recorded.

For weight studies, the resulting adult progeny were grouped into consecutive two day periods. From both the treated and untreated groups, 100 flies replicated eight times for both sexes, were then placed in petri dishes and desiccated for 72 hours. The dishes with flies were then cooled in desiccating containers. Subsequently, they were weighed and the process repeated to derive a constant weight.

Except for weight studies which were based on 14 days, the investigation was discontinued 21 days following initial oviposition because egg production was almost negligible thereafter.

All data were statistically analyzed for significance.

On a cumulative total basis the treated flies produced more eggs than the untreated during the first 14 days. Production was about equal through the nineteenth day, and less (2,760,592) than the untreated (2,957,722) by the twenty-first day.

There were more female fly days in the treated group from the second to the eighth day, and less from the thirteenth through twenty-first day, at which time the treated totaled 97,099 and the untreated 118,682 female fly days.

The cumulative average number of eggs per female fly day in the treated group was greater throughout each of the 21 days, averaging 28.4 for the treated group and 24.9 for the untreated group.

The fact that at the end of three weeks the cumulative egg production of the treated was less than the untreated while the treated exceeded the untreated in eggs per female fly day is explained by the fact that the female fly days, although greater in the treated than in the untreated during the first eight days, actually underwent a highly significant reversal thereafter. This means that the eventual outcome of egg production was the result of a large reduction in numbers of treated flies available to lay eggs during this period.

The treated flies produced eggs with a greater percentage of hatchability, resulting pupation and resulting emergence during the first week. However, there was a reversal sometime during the second and third weeks. The total for twenty one egg laying days resulted in the treated undergoing a greater mortality in the egg (2.8 per cent), between the pupal and adult stage (3.3 per cent) but a lesser mortality between the larval and pupal stage (5.6 per cent). The overall difference, i.e., between egg and adult, however, resulted in the treated suffering greater mortality than the untreated (0.5 per cent) indicating that the losses suffered between egg and larva, and between pupa and adult exceeded the gain between larva and pupa.

The potential adult progeny to have been expected from actual number of eggs produced was also calculated. During the first week, the treated was greater than the untreated. During the second and third weeks this trend was reversed. However, the total at the end of three weeks resulted in the treated group producing a calculated greater number of progeny than the untreated because the period of maximum egg production occurred during the first week, which coincided with the period of greatest hatchability, pupation and emergence.

Weights were based upon constant dry weight of eight replicates of 100 each of adult progeny, resulting from eggs produced during the first 14 days of egg laying by the parents. Weights of the treated flies of both sexes were less than the untreated during the first eight days, but from the ninth through fourteenth days the trend reversed. Taking the entire 14 days as a whole, the treated group (275.0 mg. and 316.2 mg. for males and females respectively) were lighter in weight than the untreated group (281.7 mg. and 323.0 mg. respectively).